INDOOR AIR QUALITY ASSESSMENT

Blackstone Town Hall
15 St. Paul Street
Blackstone, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
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Background/Introduction

In response to a request from the Blackstone Board of Health, an indoor air quality assessment was done at the Blackstone Town Hall (BTH), 15 St. Paul Street, Blackstone, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA). Complaints from employees of headaches, respiratory concerns and poor indoor air quality conditions prompted the request.

On February 28, 2003 a visit was made to this building by Cory Holmes, an Environmental Analyst in BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) Program, to conduct an indoor air quality assessment. The BTH was constructed in the early 1970's. The BTH is a multi-story brick on concrete slab building that is divided into three sections: the main building, which includes town offices, the public library, the Blackstone Police Department (BPD) and the Blackstone Fire Department (BFD).

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

BTH offices have a population of approximately 10-15 employees on a daily basis; the BFD and BPD are staffed 24 hours a day. The tests were taken under normal operating conditions and appear in Table 1.

Discussion

Ventilation

It can be seen from the Table 1 that carbon dioxide levels were below 800 parts per million parts of air [ppm] in all areas sampled. These carbon dioxide levels indicate that an adequate fresh air supply exists. Although tests reflected adequate airflow, poor ventilation/distribution complaints were reported throughout the building including the police station, library and town offices.

Ventilation is provided by a heating, ventilation and air-conditioning (HVAC) system. An air handling unit (AHU) located in a mechanical room on the ground floor provides fresh air for all areas within the BTH. The AHU draws air from the rear of the building through a large grate (see Picture 1). Air is then supplied to occupied areas by ceiling mounted air diffusers connected to the AHU via ductwork.

Return ventilation is provided by the AHU, which draws air through ceiling-mounted exhaust grilles via ducts. The exhaust for the AHU exits through a vent at the rear of the building, next to the fresh air intake (see Picture 1). Draw of air by return vents was weak in some areas. Without proper exhaust ventilation, normally occurring environmental pollutants can build up and lead to indoor air quality complaints.

Wall-mounted controls in the mechanical room activate the HVAC system. The control boxes have fan settings of "hand" (on) and "auto" (see Picture 2). All controls were set to the "auto" setting during the assessment. The automatic setting activates the HVAC system at a preset temperature. Once the thermostat reaches a preset temperature, the HVAC system is deactivated until the temperature drops below the heating set point. Therefore, no mechanical ventilation is provided until the thermostat re-activates the system. Little or no airflow was detected from supply or return vents in many areas

during the assessment. Without dilution and removal by the HVAC system, pollutants can build-up in occupied spaces and lead to indoor air quality/complaints.

In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that HVAC systems be re-balanced every five years (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population

in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix I.

Temperature readings ranged from 61° to 75° F and were below the BEHA recommended guidelines in several areas. The BEHA recommends that indoor air temperatures be maintained in a range of 70° to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Complaints of uneven heating and cooling were expressed in a number of areas. The dispatch area in the BPD contains large amounts of communication and computer equipment, and shares a thermostat that is located in an adjacent hallway. In this configuration the thermostat reads temperatures that are not representative of the dispatch area making it difficult to control temperature.

Relative humidity measurements ranged from 20 to 34 percent, which were below the BEHA recommended comfort range in all areas surveyed. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial Growth/Moisture Concern

A number of areas had water damaged ceiling tiles (see Table 1). The main entrance appears to be an area of reoccurring water damage (see Picture 3). Water-

damaged ceiling tiles can be a medium for mold growth. The ceiling tiles should be replaced after a water leak is discovered.

Exterior caulking around windows and frames was crumbling/damaged and spaces were noted around window frames (see Pictures 4-6). Replacement of caulking and repairs of window leaks are necessary to prevent water penetration and subsequent damage to building materials, which can lead to mold growth.

Other Concerns

Several other conditions, which can affect indoor air quality, were noted during the assessment. Building occupants report periodic odors of fuel exhaust in the BTH. The design of the building and its location related to the parking lot (see Figure 1/Picture 1) make it possible for vehicle exhaust emissions to be entrained by the AHU. Certain wind and weather conditions can foster the entrainment of these exhaust emissions into the building through the AHU. The process of combustion produces a number of pollutants, depending on the composition of the material. In general, common combustion emissions can include carbon monoxide, carbon dioxide, water vapor and smoke. Of these materials, carbon monoxide can produce immediate, acute health effects upon exposure. Measurable levels of carbon monoxide slightly above background were detected in the building (see Table 1).

Another potential source of vehicle exhaust emissions in the building are fire-fighting apparatus located in the engine bay of the BFD. Although the station is equipped with a mechanical exhaust system to remove exhaust from the engine bays during vehicle idling, the system has to be manually activated. The activation switch is located on a wall to the rear of the engine bay behind a large piece of equipment (see Picture 7). Due to the location and configuration of the system, it is unlikely that the system is used

routinely, allowing pollutants to build-up in the engine bay and migrate to occupied areas of the building. Several pathways exist for pollutants to enter occupied areas of the building, including spaces beneath engine bay doors and utility holes (see Picture 8).

A gas-powered snow blower was observed in the mechanical room approximately five feet from the AHU (see Picture 9). Fuel (e.g. gasoline) is a mixture that contains volatile organic compounds (VOCs) that can be irritating to the eyes, nose and throat. Residual amounts of gasoline can off-gas from this type of equipment, which can result in VOCs being introduced into the ventilation system. Gasoline containing equipment should be stored outside or in an area with continuous local exhaust ventilation to prevent the build-up of flammable vapors indoors.

BEHA staff inspected filters for AHUs and found the filters coated with dirt/dust and accumulated material (see Picture 10). A debris-saturated filter can obstruct airflow and may serve as a reservoir of particulates that can be re-aerosolized and distributed to occupied areas via the ventilation system.

Mechanical exhaust ventilation in restrooms was not functioning during the assessment. Exhaust ventilation is necessary in restrooms to remove moisture and to prevent restroom odors from penetrating into adjacent areas.

Finally, a number of insect bodies were noted above lighting fixtures in the senior center (see Picture 11). Insect parts can dry and become aerosolized and may serve as a source of allergenic material for sensitive individuals. The most likely route for insect penetration into the building is through spaces around window frames (see Pictures 4 & 5). Once inside the building, insects attracted to light appear to have entered light fixtures through small openings where they became trapped. The reduction/elimination of pathways into the building should be the first step taken to eliminate this infestation.

Conclusions/Recommendations

Occupant symptoms and complaints at the BTH appear consistent with what might be expected for conditions found in the building at the time of the assessment. These conditions present problems that will require a series of remedial steps. For this reason a two-phase approach is recommended, consisting of **short-term** measures to improve air quality and **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns within the building.

The following short-term measures should be considered for implementation:

1. Work with Blackstone town officials to develop a preventative maintenance program for all HVAC equipment building wide.
2. Change filters for HVAC equipment as per the manufacturer's instructions or more frequently if needed. Examine HVAC equipment periodically for maintenance and function.
3. To maximize air exchange the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of building occupancy independent of thermostat control (excluding engine bay exhaust system). Consider setting mechanical ventilation controls to the fan "hand" position to provide constant supply and exhaust ventilation.
4. Balance mechanical ventilation systems every five years, as recommended by ventilation industrial standards (SMACNA, 1994). Consult a ventilation engineer concerning re-balancing of the ventilation systems.
5. Remove gas-powered equipment from the mechanical room.
6. Repair roof leaks and replace water damaged ceiling tiles.

7. Periods of low relative humidity during the winter are often unavoidable for buildings in New England. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
8. Keep all doors accessing engine bays closed at all times. Install weather stripping/door sweeps around doors to prevent exhaust fume migration into occupied areas.
9. Consider replacing engine bay doors or have them repaired to eliminate spaces between doors and frames. Ensure tightness by monitoring for light penetration and drafts around doorframes.
10. Ensure all utility holes are properly sealed in both the engine bay and their terminus to eliminate pollutant paths of migration.
11. Consider contacting the BEHA 's ER/IAQ program to conduct a more thorough IAQ assessment of the Blackstone Fire Department facilities.
12. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.
13. Use IPM to remove pests from the building. A copy of the IPM recommendations can be downloaded from the Internet at http://www.state.ma.us/dfa/pesticides/publications/IPM_kit_for_bldg_mgrs.pdf. Activities that can be used to eliminate pest infestation may include the following:
    i) Consult a licensed pesticide applicator on the most appropriate method to end infestation.

ii) Reduce/eliminate pathways (e.g., spaces under doors)/food sources that are attracting pests.

iii) Reduce harborages (plants/cardboard boxes) where pests may reside.

The following **long-term measures** should be considered:

1. Consider installing an automatic control to activate the engine bay exhaust system as engine bay doors open. Examine the feasibility of connecting this system to the exhaust vent in the fire pole access room.
2. Consider the feasibility of relocating the vehicle parking area further away from outside air intakes to avoid the entrainment of vehicle exhausts. If not possible, consider contacting an HVAC engineering firm to examine alternative options (e.g. installing ductwork to draw from roof level).

References

BOCA. 1993. The BOCA National Mechanical Code-1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL. M-308.1

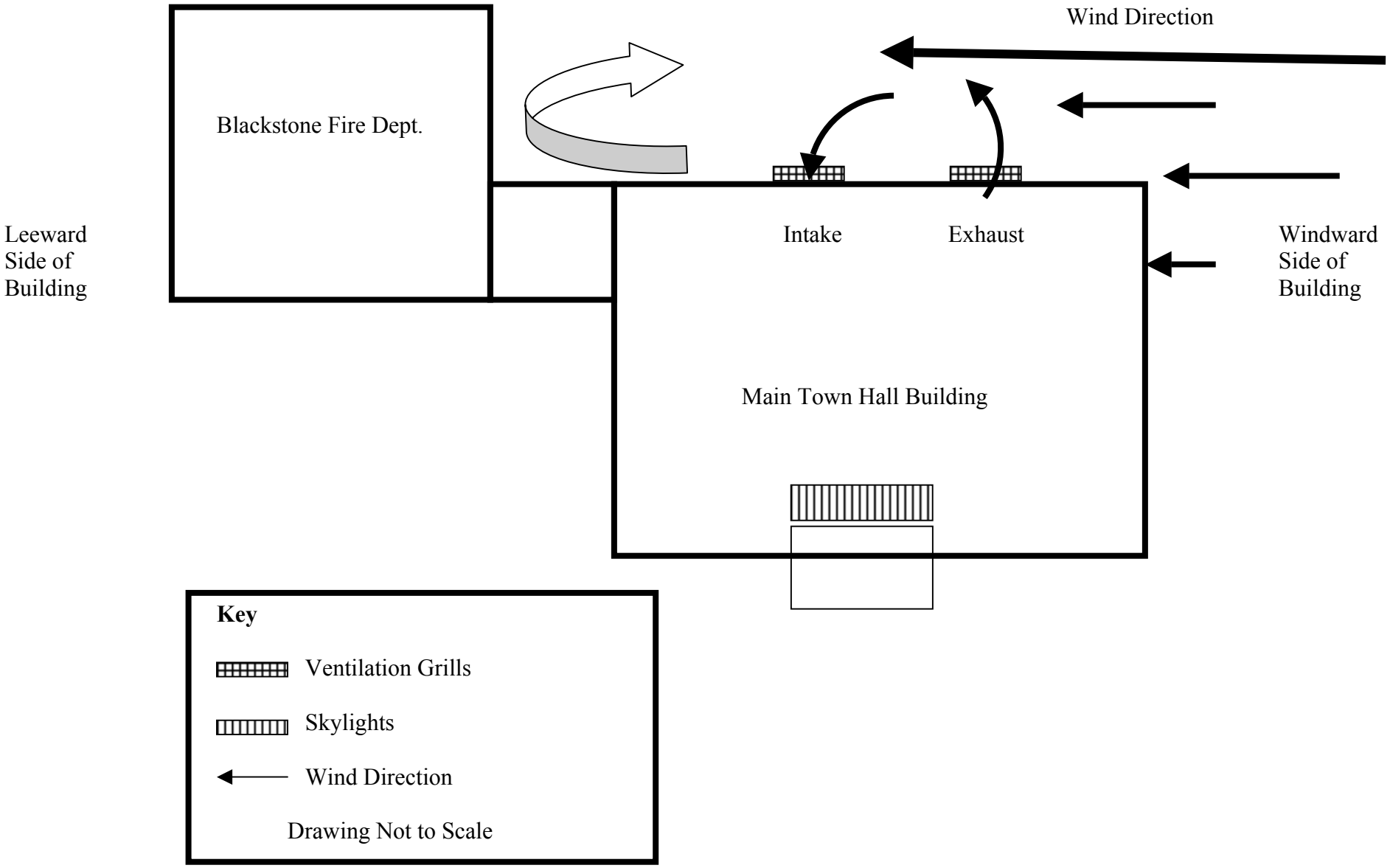
MDFA. 1996. Integrated Pest Management Kit for Building Managers. Massachusetts Department of Food and Agriculture, Pesticide Bureau, Boston, MA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

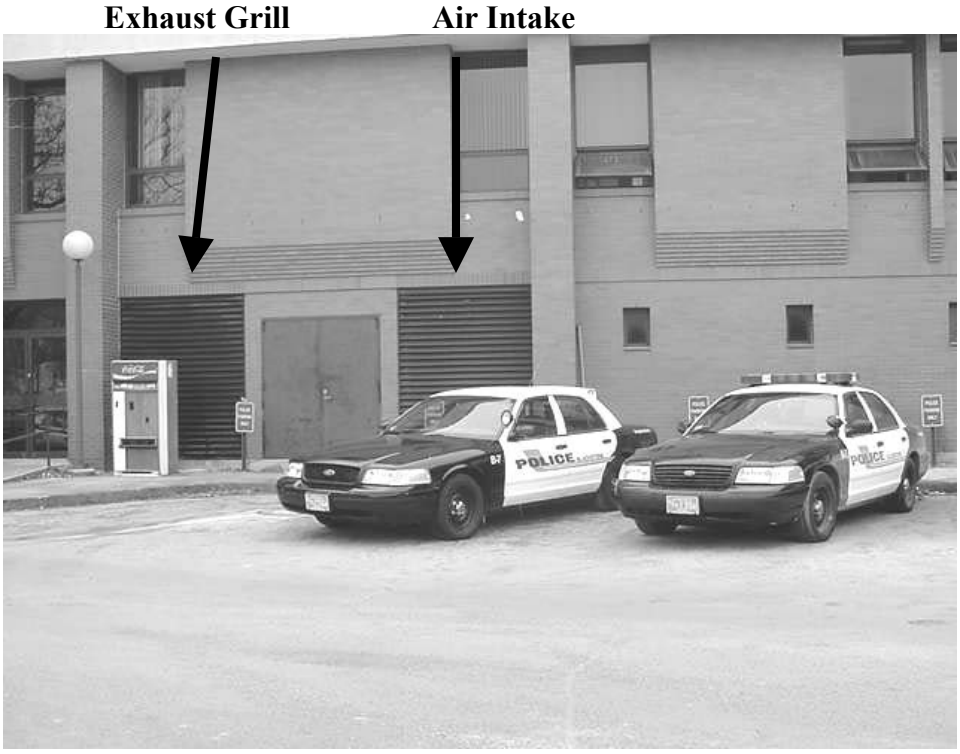
SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, WV.

Figure 1 **Blackstone Town Hall**



Picture 1



Air Intake Grill on Rear of Building, Note Proximity of Vehicle Parking

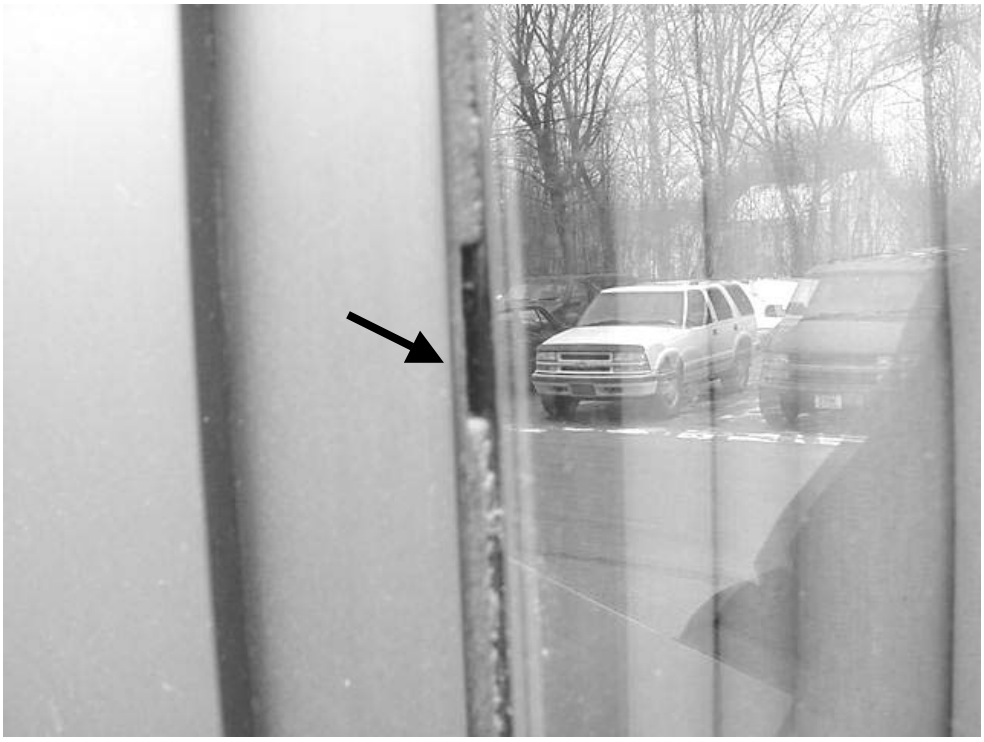
Picture 2

Supply Fan Control for Ventilation System set to "Auto"

Picture 3

Water Damaged Ceiling Tiles in Main Hallway

Picture 4

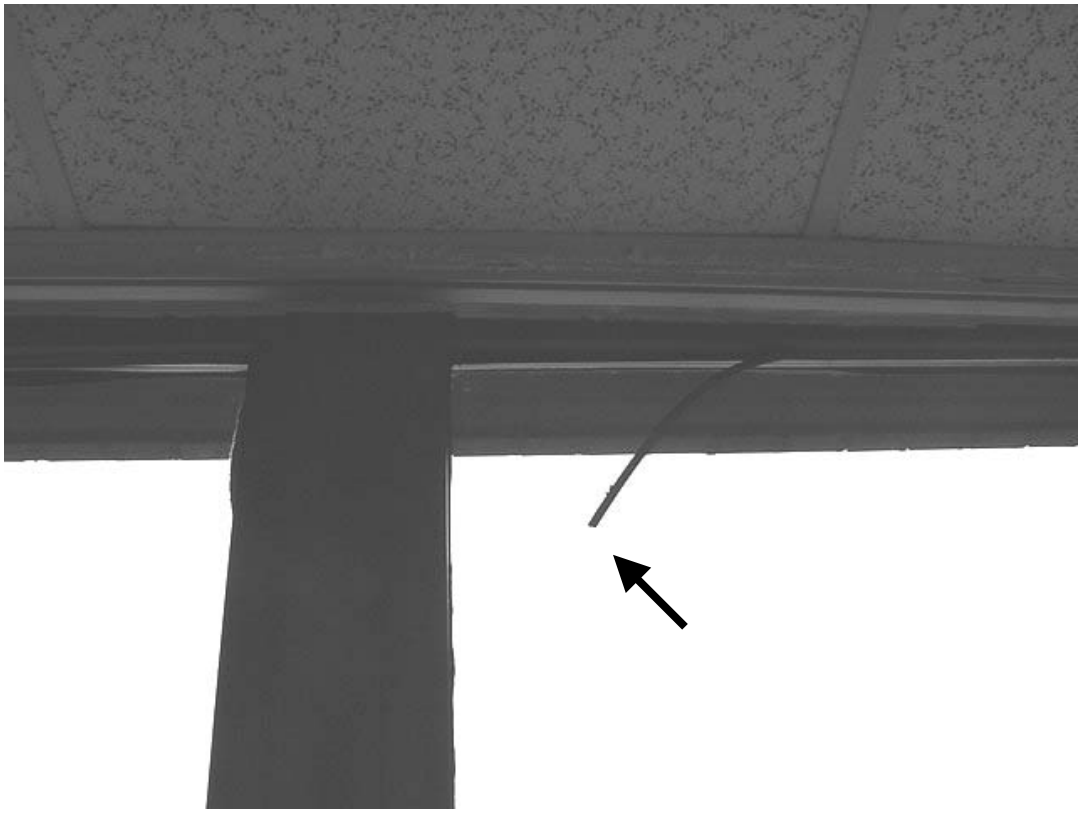


Missing/Damaged Window Caulking (Senior Center)

Picture 5

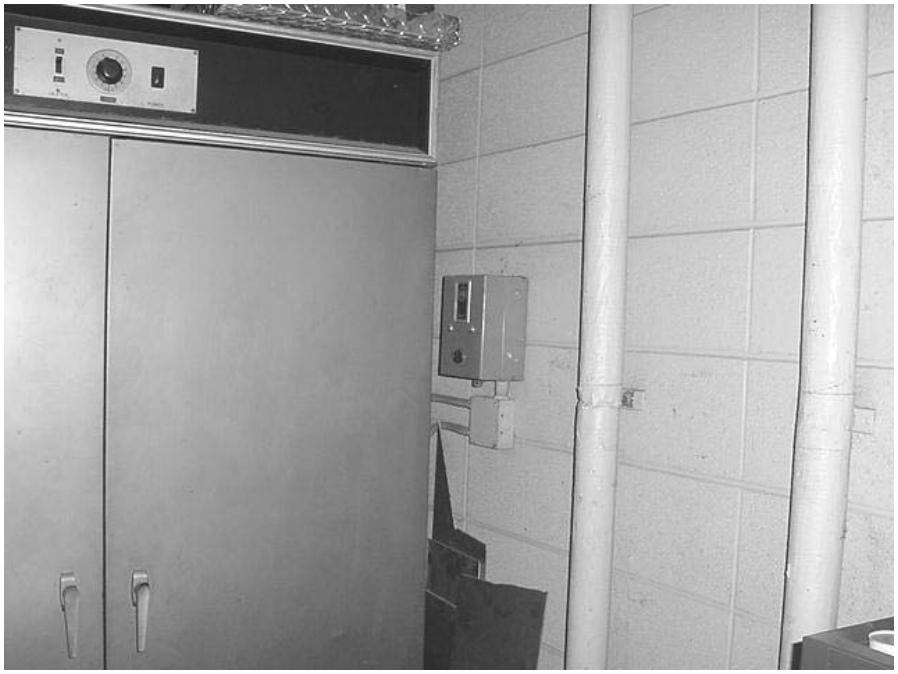
Damaged Window (Senior Center)

Picture 6



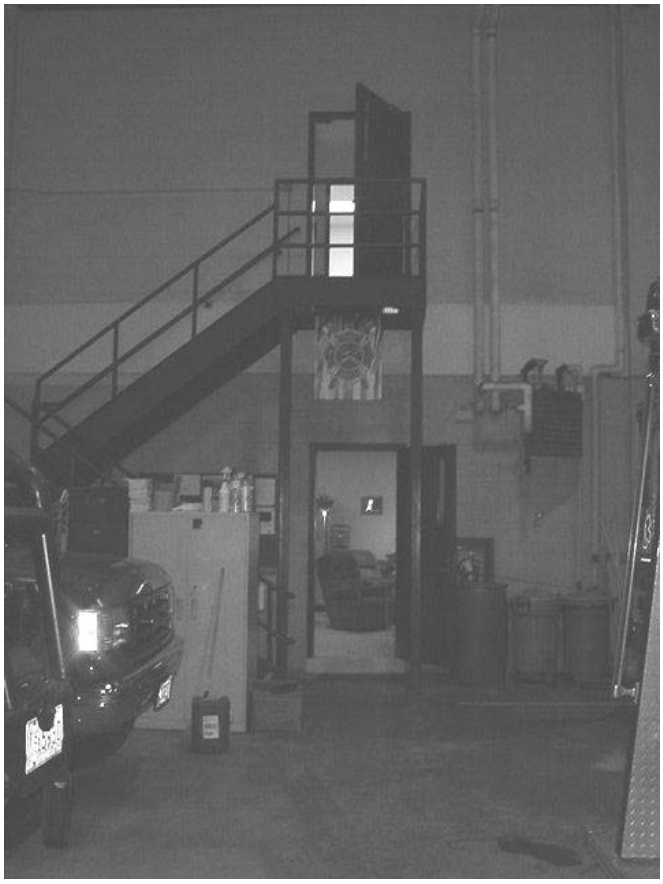
Damaged/Missing Window Seal

Picture 7



Wall-Mounted Activation Switch for the Engine Bay Exhaust System

Picture 8

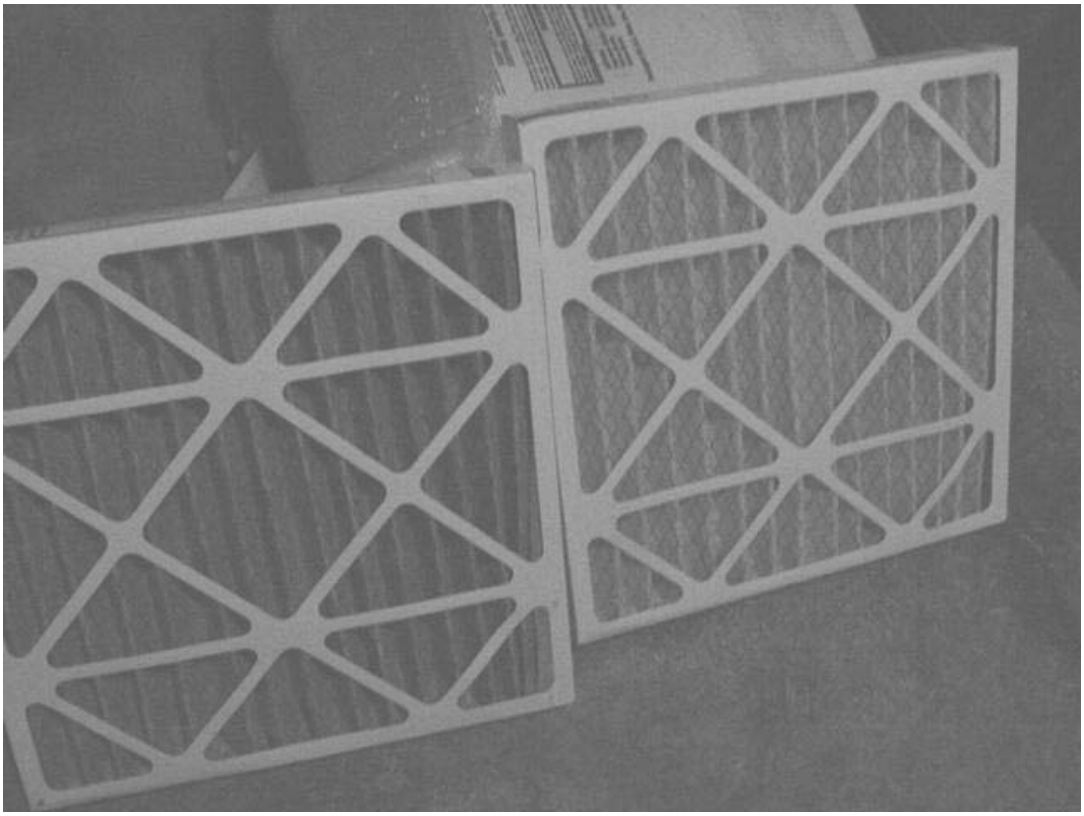


Engine Bay Doors (Upper and Lower) That Open into Occupied Areas

Picture 9

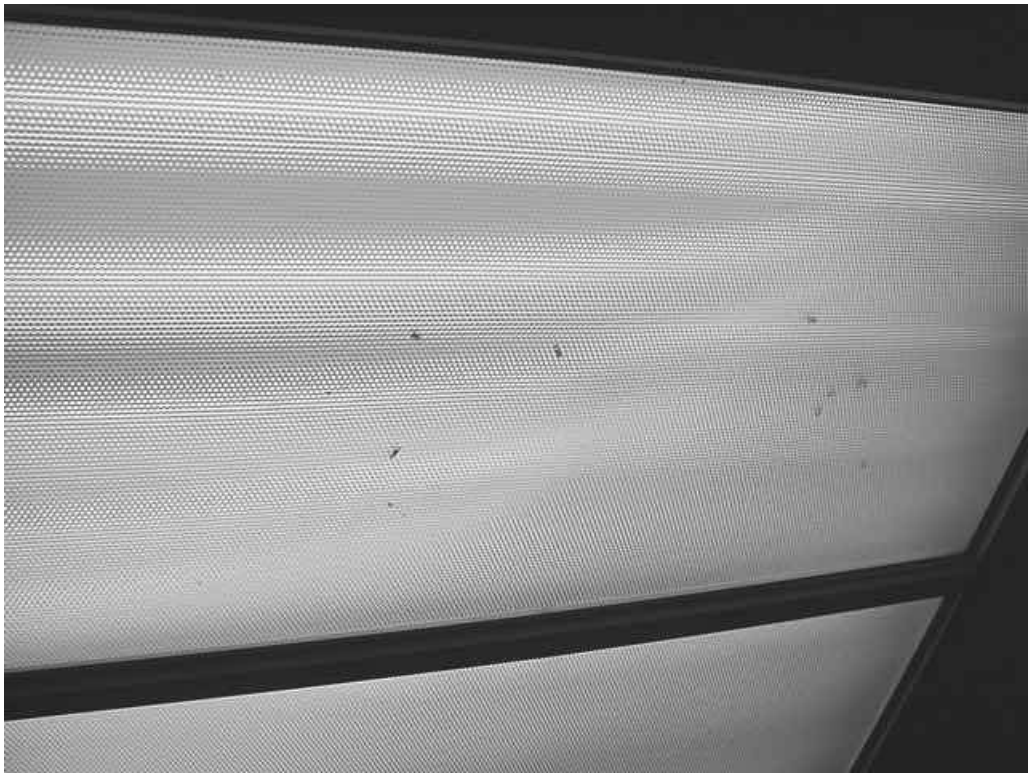
Gas-Powered Snow Blower Stored in Mechanical Room Near AHU

Picture 10



Dirty Filter for AHU on Left, Unused Filter on Right

Picture 11



Insect Bodies Represented by Dark Spots above Lighting Fixtures in Senior Center

TABLE 1-1

Indoor Air Test Results – Blackstone Town Hall, 15 St. Paul Street, Blackstone, MA – January 31, 2003

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	458	56	24					Overcast, dry, CO = 0-1 ppm
First Floor Main Entrance								WD CTs, MT, WD pipe insulation
Library	581	63	30	5	Yes	Yes	Yes	WD CTs, poor airflow, louvers for air diffuser almost shut, RR exhaust vent not operating, holes in CTs
Custodial Closet					No	Yes	Yes	Supply vent operating, exhaust vent not operating: pressurized, cleaning chemicals & wet mops and buckets
Lower Level Restroom					No	Yes	Yes	Supply vent weak, exhaust vent not operating
Fire Department Lounge	573	61	32	2	No	Yes	Yes	Door open to engine bay CO = 0
Engine Bay	529	71	34	0	No	No	Yes	Ceiling fans, door open, CO = 2

*** ppm = parts per million parts of air**
CT = ceiling tiles
MT = missing tiles
WD = water damaged
CO = carbon monoxide

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 1-2

Indoor Air Test Results – Blackstone Town Hall, 15 St. Paul Street, Blackstone, MA – January 31, 2003

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Berthing Area (off engine bay)	529	71	24	0	No	Yes	Yes	No air flow detected from vents
Training Room	547	72	23	0	Yes	Yes	Yes	MTs, WD CTs, Poor air flow
Secretary's Office	570	72	23	1	Yes	Yes	Yes	
Fire Chief's Office	561	72	22	0	Yes	Yes	No	
Mechanical Room								Used for storage of materials, gas-powered snow blowers near air handling unit (five feet)
Dispatch	642	75	21	2	Yes	Yes	Yes	Broken CT, no independent thermostat, exhaust fume complaints, temperature (heat) complaints, WD CT
2nd Floor Police Hallway								10 + CT along sky light, AC
Police Chief	561	75	20	2	Yes	Yes	Yes	Door open

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TABLE 1-3

Indoor Air Test Results – Blackstone Town Hall, 15 St. Paul Street, Blackstone, MA – January 31, 2003

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Booking Desk	660	75	20	0	No	Yes	Yes	MTs, broken CTs, WD CTs, heat complaints, poor ventilation in holding cell area, CO = 2
Town Clerk	603	69	25	1	Yes	Yes	Yes	Photocopier under thermostat
Treasurer	548	72	22	2	Yes	Yes	Yes	CO = 1
Assessor's Office	598	73	22	2	Yes	Yes	Yes	Poor airflow
Meeting Room	528	73	21	4	Yes	Yes	Yes	
2nd Floor Restroom						Yes	Yes	Ventilation not operating
Selectman's Office Reception	551	73	21	1	Yes	Yes	Yes	Humidifier
Selectman's Office	540	74	21	0	Yes	Yes	Yes	2 CT
Board of Health Conference Room	553	74	20	0	Yes	Yes	Yes	Photocopier

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TABLE 1-4

Indoor Air Test Results – Blackstone Town Hall, 15 St. Paul Street, Blackstone, MA – January 31, 2003

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Board of Health Office	633	75	20	1	Yes	Yes	Yes	Missing floor tiles
Senior Center	577	72	21	10	Yes	Yes	Yes	Missing/damaged caulking drafts spaces around window frames-sealed with clear tape, 1 CT, flying insects (bees, etc.), carpeted
(Outside) Perimeter of Building								Spaces around window frames, bee & wasp nests around building, vehicles parked in vicinity of air intakes

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